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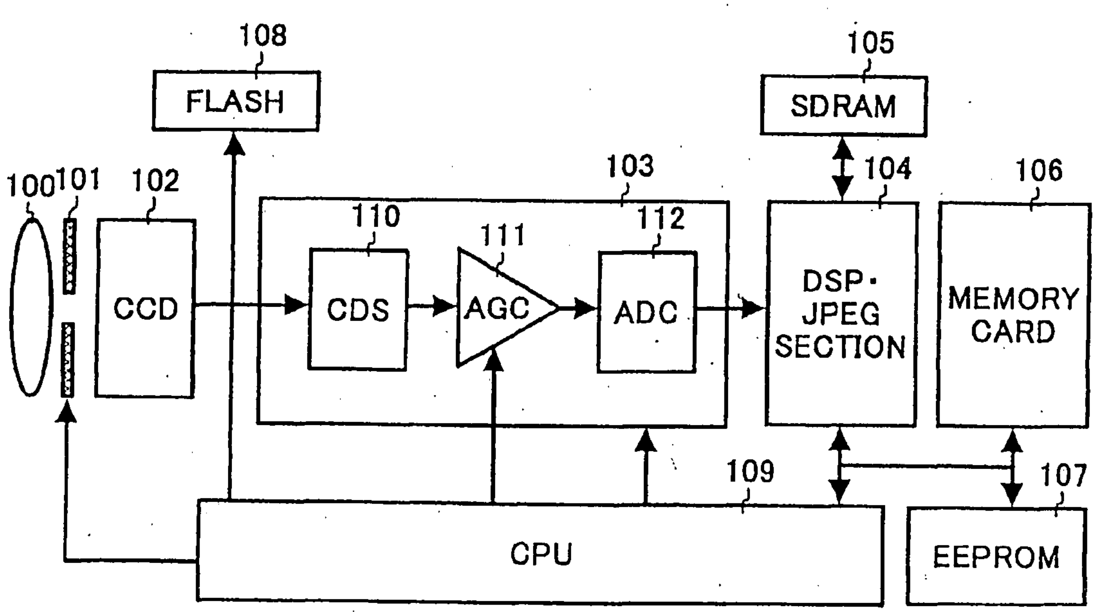
(54) **Device and method for image pickup**

(57) An image pickup device includes a CCD which picks up an image of a subject, and a front end processor which corrects data for the picked-up image by a light quantity distribution correction table for correcting the data for the picked-up image based on a light quantity distribution when the image is photographed using a flash.

FIG. 1



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is photographed using a flash (step S402). A signal (image pickup data) output from the CCD 102 is subjected to CDS processing (sampled and held) by the CDS 110 (step S403).

[0024] The CPU 109 reads correction data from the correction table stored in the EEPROM 107 and sets the correction data in the AGC 111 (step S407). The AGC 111 conducts automatic gain control to the image pickup data while changing gains based on the set correction data (step S404). The image pickup data subjected to automatic gain control is converted to digital data by the ADC 112 (step S405) and then subjected to camera signal processing (step S406).

[0025] The correction coefficient table used to correct the image pickup data by the DSP/JPEG processor 104 will be explained below. Fig. 5 is a block diagram showing the configuration of the DSP/JPEG processor 104 which performs camera signal processing. Four pieces of raw data (R, Gr, Gb, and B) from the CCD are input into the DSP/JPEG processor 104 where these four pieces of data are branched into four color signals by a multiplexer 502 and fed to variable gain amplifiers 503a to 503d, respectively. The amplifiers 503a to 503d are used to perform correction and setting of white balance (WB) of the present invention.

[0026] The gains of the variable gain amplifiers 503a to 503d are controlled by the CPU. When an operation according to the first embodiment is to be performed, gain tables by as much as the number of all the pixels of the CCD are used. The tables are stored in the EEPROM 107 shown in Fig. 1. The DSP/JPEG processor 104 also includes an evaluation value generation block. The evaluation value generation block operates four integrated values of, for example, ΣR, ΣGr, ΣGb, and ΣB to thereby generate an evaluation value. The CPU 109 determines the state of the image from the evaluation value thus generated and performs setting of WB and corrections to the respective signals. The signals passing through the variable gain amplifiers 503a to 503d, respectively, are transformed to RGB signals by a 4 × 3 matrix 504 provided in the next stage and fed to a luminance signal/color signal processor.

[0027] Fig. 6 is a flow chart of processing performed by the DSP/JPEG processor 104 when the processor 104 corrects image pickup data. The digital camera first acquires information on the distance of the digital camera to a subject using the number of pulses which are generated during an AF operation (step S601). The subject is photographed using a flash (step S602). A signal (image pickup data) output from the CCD 102 is subjected to CDS processing (sampled and held) by the CDS 110 (step S603).

[0028] The image pickup data thus CDS processed is output to the AGC 111 and the gain of the image pickup data is controlled by the AGC 111 (step S604). The ADC 112 converts the data to digital data (step S605) and further subjects the digital data to camera signal processing (step 606). At this moment, the CPU 109 reads the correction coefficient table from the EEPROM 107 and sets correction coefficients as the coefficients of the variable gain amplifiers that are set according to the pixels of the CCD (step S607).

[0029] According to the image pickup device of the first embodiment explained so far, it is possible to provide an image pickup device which can prevent the degradation of image quality due to an uneven luminous intensity distribution and which can form a high-quality image even if a subject is photographed using the flash from a relatively short distance. In addition, according to the image pickup device of the first embodiment, there is no need to locate the flash at a position near the optical system in the digital camera, thereby making it possible to improve the degree of freedom to design the layout of the digital camera.

[0030] According to the first embodiment, the hardware configurations of the circuits and the flash are not changed. Therefore, it is possible to prevent the circuits mounted on the digital camera from being complicated in configuration, made large in size and to prevent cost from increasing. Thus, it is possible to correct the uneven luminous intensity distribution without preventing the digital camera from. being made smaller in size and lighter in weight and preventing the cost thereof from increasing.

[0031] The present invention is not limited to the configuration which has been explained so far but may have the following configuration. For example, the digital image pickup device normally performs shading correction to correct the uneven luminous intensity distribution of an image pickup region which occurs because of the shading. Figs. 7A and 7B explain an uneven luminous intensity distribution caused by shading. When the image of a line L shown in Fig. 7A is picked up, the uneven luminous intensity distribution caused by shading is represented as a decrease in the light quantity of the end portions of the line L as shown in Fig. 7B.

[0032] According to the image pickup device explained in the first embodiment, a correction characteristic for subjecting image pickup data to shading correction can be also added to the correction table. The correction characteristic is an opposite characteristic to the light quantity distribution shown, for example, in Fig. 7B. The correction table or correction coefficient table of the gain amplifier is set in the EEPROM 107. More specifically, the correction table shows the opposite characteristic to the characteristic obtained by adding the light quantity distribution shown in Fig. 7B to the light quantity distribution shown in Fig. 2B. By thus setting, the image pickup device can simultaneously execute the correction during stroboscopic photographing and shading correction.

[0033] The luminous intensity distribution during stroboscopic photographing is often influenced by external light. In this case, a trouble may occur when image pickup data is corrected using the correction data as explained in the first embodiment. To prevent this possible

disadvantage, as shown in Fig. 8, the image pickup device according to the present invention may include a switch 801 in addition to the constituent elements shown in Fig. 1. This switch 801 is used to select whether or not the image pickup data is to be corrected. Therefore, an operator can select execution or non-execution of the correction using the switch. Alternatively, according to the present invention, the CPU 109 automatically detects an uneven luminous intensity distribution from the image pickup data picked up by the CCD 102 and determines whether or not correction is to be executed.

[0034] According to the image pickup device of the first embodiment, the correction of image pickup data on a binary image such as a character image can be executed by lowering correction accuracy. The correction accuracy can be lowered by, for example, setting the resolution of the correction table to be coarse. Alternatively, the correction accuracy can be lowered by lowering the resolution (the number of bits) of each correction data k(m, n).

[0035] A threshold table is generally required for processing of image pickup data for a binary image. In the first embodiment, the image pickup data for the binary image is processed using the threshold table in which thresholds multiplied by the respective correction data set in the correction table shown in Fig. 3 are set, and it is thereby possible to correct the uneven luminous intensity distribution caused by the flash simultaneously with the binarization of the image pickup data.

[0036] A second embodiment of this invention will be explained below. An image pickup device of the second embodiment has the same configuration as that of the first embodiment, and therefore the constituent elements of the image pickup device are not explained or shown in the drawings partially.

[0037] In the image pickup device of the second embodiment, the EEPROM 107 holds a plurality of correction tables explained in the first embodiment. In addition, the CPU 109 corrects image pickup data using the correction table which corresponds to a distance between the device and a subject measured from the number of pulses which are generated when the auto-focusing section 101 is driven or the distance measured by an external AF sensor 901.

[0038] That is, the image pickup device of the second embodiment stores in the EEPROM 107 a plurality of correction tables which correspond to the distances between the digital camera and a subject, respectively. The CPU 109 measures the distance of the digital camera to the subject, selects and reads the correction table which corresponds to the obtained distance, and sets the read correction table in the AGC 111 or the DSP/JPEG process or 104. An uneven luminous intensity distribution during stroboscopic photographing changes according to the distance to the subject. Therefore, according to the image pickup device of the second embodiment, it is possible to correct the image pickup data using correction data which corresponds to an uneven luminous intensity distribution closer to an actual uneven luminous intensity distribution and to correct the image pickup data more appropriately.

[0039] If there is no correction table which corresponds to the distance obtained by measurement in the EEPROM 107, the image pickup device of the second embodiment corrects the image pickup data by linear interpolation using the correction table stored in the EEPROM 107. According to the image pickup device of the second embodiment, the image pickup data can be corrected more appropriately while the number of correction tables to be stored is suppressed.

[0040] The image pickup device of the second embodiment is not limited to the configuration in which the distance of the device to the subject is measured from the number of pulses which are generated when the auto-focusing section 101 is driven. The image pickup device may also include an external AF sensor 901 as shown in Fig. 9. If including the external AF sensor 901, the image pickup device of the second embodiment selects the correction table which corresponds to the distance measured by the AF sensor 901 and uses the table for correcting the image pickup data.

[0041] A third embodiment of this invention will be explained below, and an image pickup device of the third embodiment will be explained. The image pickup device of this embodiment has the same configuration as the image pickup device shown in Fig. 1 or Fig. 9. Therefore, the constituent elements of the image pickup device of this embodiment will not be explained or shown in the drawings partially. The third embodiment is provided to solve the problem as follows. That is, when a binary image is to be picked up, binarization accuracy is higher as signal level is higher. If the light emission quantity of the flash is increased excessively so as to increase the signal level, a white void or white voids may occur in a picked-up image.

[0042] In the third embodiment, when the digital camera picks up a binary image, the CCD 102 controls the flash 108 so as to emit light at least twice in different light quantities to pickup an image of a subject. The CPU 109 then corrects image pickup data using the data for the images picked-up in different light quantities.

[0043] In the third embodiment, the CPU 109 controls the CCD 102 and the flash 108 to photograph the subject twice. This photographing is performed by changing the quantity of light emitted from the flash. The larger quantity of light emission is set as light emission quantity 1 and the smaller quantity of light emission is set as light emission quantity 2. The light emission quantity 1 is set to a quantity in which a sufficient signal level for necessary binarization accuracy is obtained. The light emission quantity 2 is set to a quantity in which no white void occurs.

[0044] In the third embodiment, the CPU 109 controls the CCD 102 to photograph a binary image of the subject in the light emission quantity 1 for the first time. Image pickup data (image pickup data 1) obtained by the